#5 Contract I

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Monthly Progress Report for February 1962

RESEARCH AND DEVELOPMENT OF HIGH EFFICIENCY LIGHTWEIGHT SOLAR CONCENTRATORS

Prepared for

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OTS PRICE

XEROX $ 1.10 ph

MICROFILM $ 0.80 mf.

ELECTRO-OPTICAL SYSTEMS, INC. - PASADENA, CALIFORNIA

This report covers the period from 1 February, 1962, through 28 February, 1962, and is submitted in accordance with the provisions of the referenced contract.

A. ACCOMPLISHMENTS

During this reporting period, which covers the fourth month of effort on the program, progress was made in the following areas of activity.

1. Concentrator Design

Concentrator design efforts remain suspended pending further and more conclusive results from the first small-scale structural studies.

2. Small-Scale Studies of Support Structures

During this period work was continued on variations of the back-mounted torus design and experimental platings were accomplished. The two basic joining approaches discussed in the last report were experimentally evaluated, and difficulty was encountered at the point of joining to the reflective skin at the outer rim. The attachment of the secondary plating produced a small amount of stress which was sufficient to create localized distortion in this area and, in some cases, produced leakage which discolored and degraded the reflective surface at the rim. Various masking techniques and anode placements were tried in an effort to minimize this condition. Preliminary platings indicated, however, that the technique of attaching the torus by secondary plating to the reflective skin will be acceptable if this distortion and leakage problem can be overcome.

3. Sixty-Inch Diameter Concentrator Development

Various methods of supporting the 60-inch diameter glass masters in the inverted position and attaching them to the rotater are being considered. Large suction cups have been obtained to test under experimental loading conditions and appear to be adequate for support over short periods of time, It has not been established, however, whether this will be a satisfactory method for long periods of support, particularly when the surface is exposed to plating solutions, water, or other liquids. Other methods for attachment which are being considered include attachment by adhesives at many points around the rim, and rim mounting by means of a clamp or banding arrangement. All of the techniques must be capable of adjustment so that the master can be leveled or brought into plane at the rim and held at this position during plating. It is desirable, also, that the chosen methods attach and support from the back so that the entire glass surface of the glass master, including its rim, or outer edge, can be utilized for the plating process. A lock-on around the edge during platings will minimize the possibility of leakage and damage to the reflective surface.

Fabrication work is continuing and the drive motor gear reduction mechanism has been ordered. Fabrication is also continuing on the handling fixture which will be capable of supporting the 60-inch concentrators in all attitudes from horizontal to vertical. This fixture sill also provide the capability of rotation if desired.

4. Plating Studies

The analytical and control techniques have been put into use and certain modifications made in procedures to optimize the entire operation. Schedules are being established for total evaluation of the plating solutions and plating conditions so that all conditions will be evaluated on a regular basis. Stress tests have been continued using the modified strip testing techniques to determine the decay rate of additives and reproducibility of the test technique itself.

Initial physical property tests have been completed on samples plated in the normal sulfamate nickel solution without stress reducers. Three test coupons were pulled to obtain tensile strength, yield, and percent elongation. Modulus was determined from the test data and resultant curves. The information agreed reasonably well with published data supplied by the plating solution manufacturers. The following table lists the results of these initial tests.

Tensile Test	Sample 1	2	3
Tensile Strength psi	80,000	81,700	83,500
Yield Point psi 0.2% offset in 2 inches	52,400	53,600	54,600
Percent Elongation	12%	10%	7.5%
Youngs modulus $x10^6$ at 5,000 psi stress	12.5	10.4	10.9

Microhardness Measurements

Knoop Diamond Indenter

Sample	Matrix Side	Edge
1	KHN 247	KHN 199
2	KHN 257	KHN 199
3	KHN 252	KHN 202

Hardness tests were also made on these samples. Hardness was measured both on the reflective surface and on the edge of the test strip. As can be seen in the table, the samples exhibited greater hardness characteristics on the reflective surface, which is probably the result of the finer grain structure which occurs at this point; the initial deposition of the nickel being similar in structure to the sensitized silver surface on which it deposited.

Additional test plates have been produced with varying bath temperatures, maintaining all other parameters. These parts will be tested in the near future.

An effective chromium plating solution has been achieved for providing a highly reflective chromium overcoat on reflective nickel samples. In an effort to obtain optimum results from the chromium bath, the second of the two methods discussed in the last report, that of applying the chromium to the reflective face of a nickel sample from which the silver had been stripped, was chosen. A number of electroformed nickel reflective surfaces have been overcoated with chromium produced from this bath. These samples have been included with the other reflectivity samples for testing. The appearance of the chromium plated parts is quite good visually, and the abrasion resistance appears to be excellent. Further tests will involve attempts to produce the chromium layer directly on the sensitized glass with the structural deposit of nickel or copper being deposited subsequently.

Considerable difficulty was experienced in determining the best range of current densities and general configuration within the bath to provide maximum brightness of plate without the need for any subsequent polishing. It appears, however, that a reasonably broad range of conditions can be achieved which will permit plating to the necessary degree of brightness.

Test platings of copper have been achieved using the normal copper sulfate bath to produce test coupons for initial testing of physical properties. As soon as a base or control condition has been established and tested, the various additives or additive combinations will be investigated with sample platings at each point in an attempt to determine the properties which result from each of the varying conditions.

5. Coating Studies

Approximately 50 electroformed nickel sample surfaces have been made for the reflectivity tests. Approximately half of these have had the required reflective and protective overcoatings applied as of the end of this reporting period. It is expected that coating will be completed within approximately two weeks. Four samples were made of each particular combination of coating. Specular reflectivity measurements will be made on one of each of the four samples. A slight delay was experienced in the reflectivity measurements due to an uncertainty in the accuracy of the standard surface used in the Perkin-Elmer Spectrophotometer. New aluminized samples have been prepared and reflectivity measurements will continue using one of these new standards. The second standard is being sent to the Bureau of Standards for calibration and will in turn be compared with the original standard when its reflectivety qualities are known. At Mr. Leventhal's request, after EOS evaluation of reflectivity, the first sample of each coating combination will be forwarded to Jet Propulsion Laboratory for further reflectivity evaluations.

The remaining three samples of each coating combination will be used in the testing program. One sample will be exposed to temperature cycling from ambient to 500°F; first under normal atmospheric conditions and subsequently under various artificial environments. The second sample will be exposed to weather conditions for the duration of the program and examined from time to time during the course of exposure. Exposure will, of course, include sunlight, dust, smog, rain, etc. The third sample will be subjected to standard salt spray corrosion tests. Depending on the durability and physical appearance of each of the samples during the course of exposure and testing, reflectivity tests will be made at various time intervals on the different samples, and all samples will be re-tested to determine reflectivity or degree of degradation.

B. FUTURE EFFORTS

During the next month's reporting period, work will continue or be undertaken in the following areas:

1. Structural design work will continue as more information is available from the small-scale studies. The work will include an evaluation of the concept of segmented concentrators which are pre-assembled to a rigidizing structure and optically aligned.

2. Small-scale plating developmental studies will continue on variations of the rear-mounted torus in the 18-inch diameter sizes. Control of leakage or other factors causing distortion or loss of reflective area and optimum joining methods will be key areas of activity.

3. Fabrication will continue on rotating fixture and handling fixture for the 60-inch diameter concentrators.

4. Plating studies will continue with emphasis on investigation of the various parameters of the nickel bath. A large number of physical property tests will be made on the resultant materials. Platings will also be made while varying substrate material and holding all other conditions constant to determine the effect on the initial layers and deposition caused by the various substrate conditions.

5. Coating studies will continue as outlined. Work on multiple coatings prior to electroforming will be re-emphasized since considerable success has been achieved in the samples to date. Electrodeposited rhodium overcoatings will be evaluated in conjunction with the electrodeposited chromium overcoatings which have been produced to date.